
TWO NEW SPECIES OF *CALYPTROCARYA* (CYPERACEAE: SCLERIEAE) FROM VENEZUELA AND OBSERVATIONS ON THE INFLORESCENCE MORPHOLOGY OF THE GENUS¹

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ABSTRACT

Two new species, *C. montesii* and *C. delascioi*, are described from Guárico, Venezuela. Both species have multiple, sessile, headlike inflorescences. *Calyptrocarya delascioi* is the first species in the genus with elongated rhizomes. *Calyptrocarya montesii* is the second species in the genus with three stigmas. A detailed discussion of inflorescence morphology is presented, demonstrating that compound male and female spikelets are borne in separate inflorescence units in all species of the genus.

A recent review of specimens of *Calyptrocarya* for a treatment in the *Flora of the Venezuelan Guayana* has brought to light two distinctive gatherings of *Calyptrocarya* from a region just north of the flora area.

This tropical American genus has been revised by Koyama (1967, 1969b), who recognized six species. The presence of two undescribed endemic taxa from a small region in the state of Guárico may seem suspicious, yet seems to be justified by their distinctive morphologies. The low mesas of Parque Nacional Aguaro-Guariquito that rise out of the llanos harbor a number of distinctive endemic elements. One of these is *Rhynchospora papillosa* W. Thomas (1984), a species recently described from Montaña de Guardahumo, in Parque Nacional Aguaro-Guariquito. Ironically, the type of *C. montesii* was collected as a mixture in the type gathering (Delascio, Montes & Davidse 11342) of *R. papillosa*.

DESCRIPTION OF NEW SPECIES

Calyptrocarya montesii Davidse & Kral, sp. nov. TYPE: Venezuela. Guárico: Distrito Miranda, Parque Nacional Aguaro-Guariquito,

Montaña de Guardahumo, ca. 8°88'–8°92'N, 67°44'W, 40–60 m, Dec. 1981, F. Delascio, R. Montes & G. Davidse 11342A (holotype, MO). Figure 1.

Species affinis *C. delascioi* a qua habitu caespitoso, culmis capitulis 2, bracteis capitulis longioribus et stigmatibus 3 differt.

Cespitose annual with lax culms and leaves. Roots fibrous, slender. Lowermost leaves mostly sheaths, short, keeled, multinerved, dull brown, friable and soon lost; principal leaves well overtopping the inflorescence, the largest lowest and more approximate with short, dull brown sheaths; blades 10–30 cm long, 3–5 mm wide, linear, thin, flat, glabrous, 3-costate, the midrib projected on the lower surface, the lateral costae projected on the upper surface, the apex abruptly acute, the margins scabro-ciliate only distally, otherwise smooth; upper leaves gradually reduced and more distant, with all but the uppermost blades elongate and overtopping the inflorescence. Culms 6–16 cm long, ca. 0.5 mm wide, all fertile, centrally borne, trigonous; nodes usually 3, the upper 2 usually bearing inflorescences; internodes glabrous with scaberulous culm angles. Inflorescence a congested head

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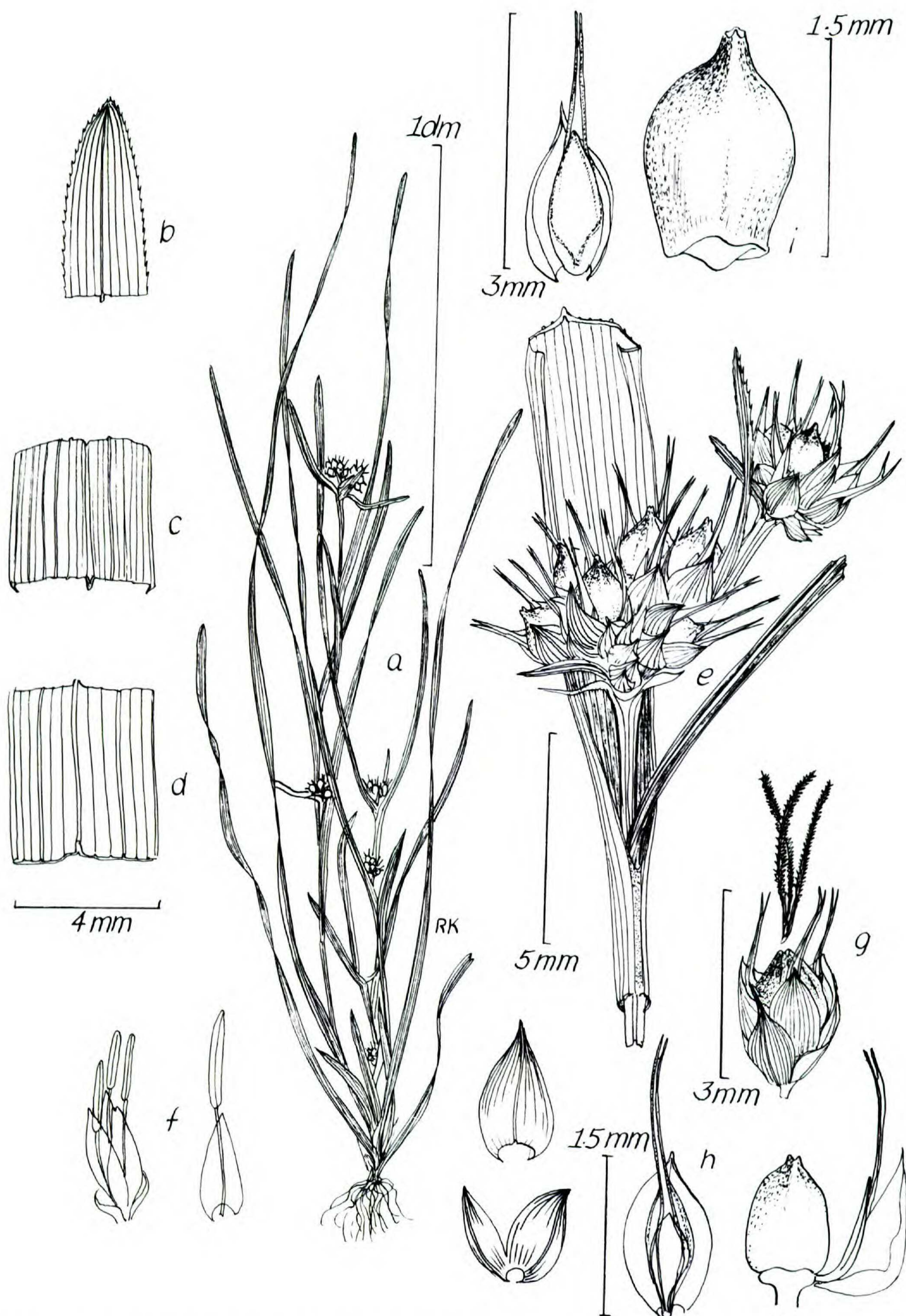


FIGURE 1. *Calyptrocarya montesii* Davidse & Kral (from holotype).—a. Habit sketch.—b. Upper surface of leaf blade tip.—c. Upper surface of mid blade.—d. Lower surface of mid blade.—e. Portion of inflorescence showing two heads composed of globose clusters of compound spikelets.—f. Staminate spikelet.—g. Young female compound spikelet.—h. Dissection of female compound spikelet, from left: lowest female spikelet bract; intermediate bract (prophyll); adaxial view of upper bract and sterile spikelet; young fruit with attached upper bract and its sterile spikelet.—i. Left, upper bract complex; right, mature fruit.

5–8 mm long and wide, composed of smaller globose clusters of compound spikelets; globose clusters sessile or nearly so; involucre bracts 1–3, leaflike, 0.5–8 cm long; lower 1–3 compound spikelets in a globose cluster male, the upper 4–8 compound spikelets female. Male compound spikelets 1.3–2.2 mm long, usually unbranched; lowest bract 1.8–2.2(–8) mm long, membranous or in the lowest spikelet of the head sometimes herbaceous and leaflike, several-nerved; prophyll 1.3–1.6 mm long, 2-keeled, membranous, truncate, inconspicuously many-nerved; bracts subtending the solitary stamens 5–7, the uppermost usually reduced and rudimentary and not subtending a stamen; male flowers solitary stamens, the filaments as long as or slightly longer than the subtending bracts at anthesis, the anthers 0.7–1.2 mm long, linear. Female compound spikelets 3.1–4.2 mm long, composed of 5 primary bracts; lowest bract 1.8–4.2 mm long, ovate, 9–15-nerved, acute or awned to 1 mm; prophyll 1–1.1 mm long, often split into 2 parts, 2-keeled, many-nerved; upper bracts 3, 1.6–2 mm long, 1.4–1.7 mm wide, herbaceous, broadly ovate, 15–19-nerved, prominently apiculate, each subtending 1 sterile, axillary spikelet and surrounding a central, terminal female spikelet; sterile spikelets 2.9–4 mm long including the pedicel, much exceeding the achene, long attenuate, the lowest bract 1.4–2.1 mm long, 2-keeled and clasping at the base, membranous, inconspicuously many-nerved, the upper bract 2.4–3 mm long, 0.4–0.5 mm wide at the base, lanceolate-linear, strongly 2-keeled, the tip of the keels free as awn points 0.1–0.3 mm long, the lateral nerves 2–4; female spikelet a solitary female flower; achenes 1.5–1.6 mm long, ellipsoid; utricle with the base triangular in outline, somewhat thickened and forming a low 3-lobed annulus, the upper part a hyaline, pale brown, smooth to minutely puberulent sac closely appressed to the achene; beak ca. 0.2 mm long; stigmas 3, ca. 1 mm long.

Calyptracarya montesii is known only from the type collection. It is named in honor of Dr. Rubén A. Montes, a co-collector of this new species.

This species is most clearly characterized by its lax foliage, sessile, multiple inflorescences, and three stigmas. The species appears to be annual, which would be unique in the genus. However, the available specimens are too few to be certain of this interpretation.

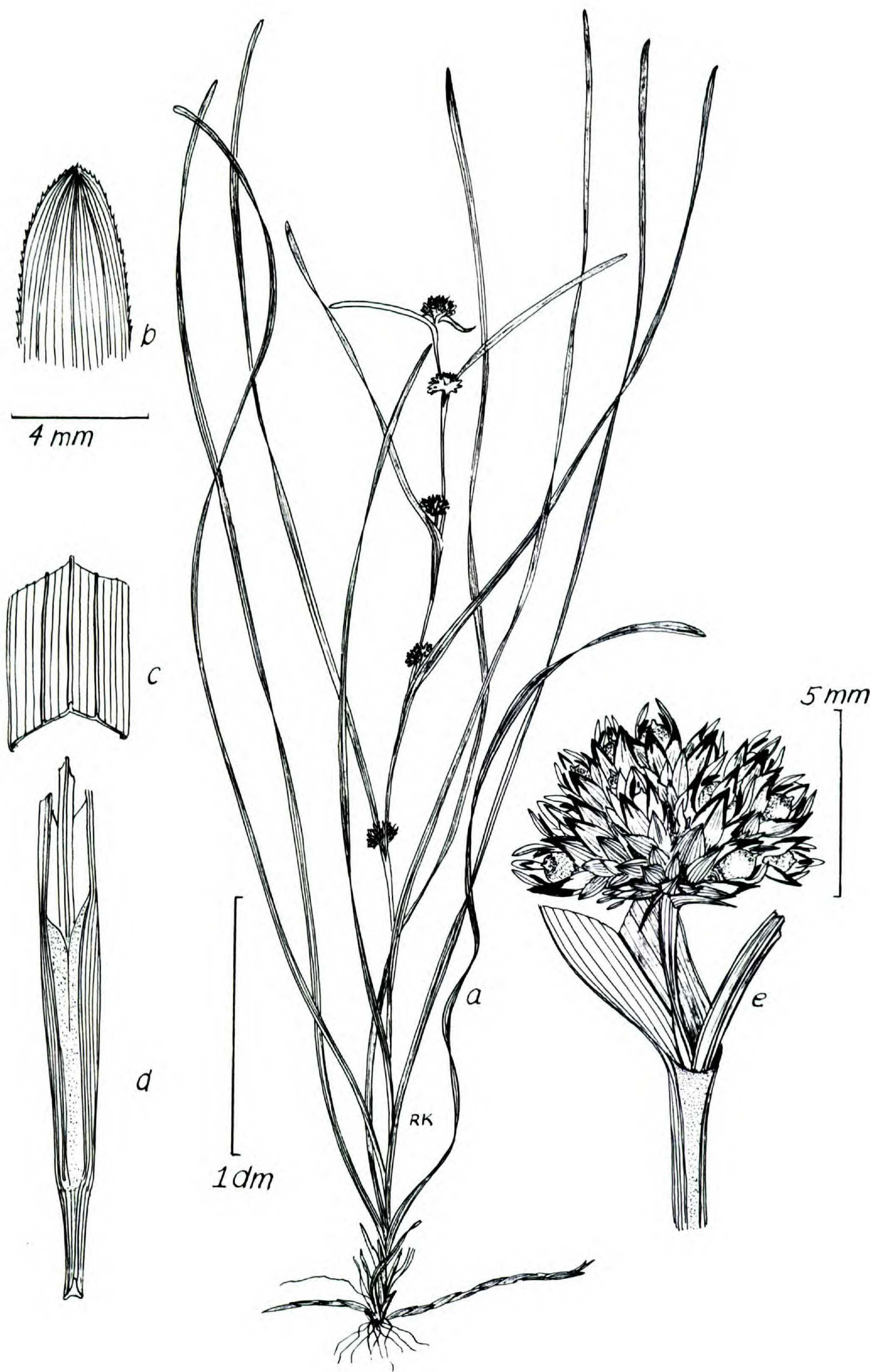
The only other species in the genus with three stigmas is *C. luzuliformis* T. Koyama, from which *C. montesii* differs by having relatively broader, laxer leaves, sessile heads, and minutely puberulent rather than pubescent utricles.

Two other species have sessile headlike inflorescences, *C. monocephala* Hochst. ex Steud. and *C. delascioi*. *Calyptracarya montesii* differs from *C. monocephala* in its multiple rather than solitary inflorescences, broader and laxer leaves, and three versus two stigmas. *Calyptracarya montesii* differs from *C. delascioi* in the lack of rhizomes, less numerous inflorescences per culm, much longer involucre bracts, smaller achenes, and three rather than two stigmas.

***Calyptracarya delascioi* Davidse & Kral, sp. nov.** TYPE: Venezuela. Guárico: Distrito Miranda, Parque Nacional Aguaro-Guariquito, Montaña de Guardahumo, ca. 8°88'–8°92'N, 67°44'W, 40–60 m, Dec. 1981, F. Delascio, R. Montes & G. Davidse 11336 (holotype, MO; isotype, VEN). Figures 2, 3.

Species rhizomatibus productis gracilibus a congeneribus diversa; folia laxa, culmi capitulis 3–8 sessilibus; stigmata 2.

Rhizomatous perennial with lax culms and leaves; aerial shoots up to 7 clumped together, all fertile; roots fibrous, slender. Rhizomes 1–10 cm long, ca. 1.5 mm thick, scaly, slender; scales 6–10 mm long, purple, multinerved, slightly dilated and open distally at the acute, sometimes bifid apex, usually slightly overlapping, passing into scalelike basal leaves. Principal leaves longest and most crowded toward the culm base, there with short, red to purple loose sheaths to 3 cm long, these ventrally scarious, brownish, nearly open, passing at the orifice into strongly folded dull-green blades; blades 30–60 cm long, 3.5–7 mm wide, well overtopping the inflorescence, linear, very lax, thin, flat, glabrous, 3-costate, the midrib projecting on the lower surface, the lateral costae projecting on both surfaces, the tip obtuse, the margin scabro-ciliate distally, otherwise a smooth nerve; upper leaves gradually shortening, but even the upper ones overtopping the inflorescences. Culms to 35 cm long, ca. 1 mm wide, lax, centrally borne, glabrous, trigonous, each angle with a strong costa, each concave face with several low ribs, nodes 3–9 (–10), all usually bearing inflorescences. Inflorescence a congested head 3.5–7 mm long, 3.5–9 mm wide, composed of globose clusters of compound spikelets; globose clusters sessile or with rays to 5 mm long; involucre bracts inconspicuous, 1–3 mm long, linear-lanceolate; lowest 2–3 compound spikelets in a globose cluster male, the upper 5–8 compound spikelets female, larger and firmer than the male compound spikelets. Male compound spikelets 1.5–2.1 mm long, usually unbranched; lowest bract 1.9–2.1 mm long, 7–11-nerved, lan-



ceolate, acute; prophyll 1.1–1.3 mm long, membranous, 2-keeled, 5–7-nerved; bracts subtending the solitary stamens 6–8, 1–1.6 mm long, lanceolate to linear-lanceolate, membranous, especially the inner, the uppermost 2–3 reduced or rudimentary and not subtending a stamen; male flowers solitary stamens, the filaments flattened, slightly longer than the subtending bracts at anthesis, the anthers 0.5–0.8 mm long, oblong-linear. Female compound spikelets 2.5–4 mm long, composed of 5 or rarely 6 primary bracts, the tips and/or upper margins conspicuously purple, otherwise pale green; lowest bract 1.9–2.3 mm long, ovate, herbaceous, 15–19-nerved, acute; prophyll 1–1.2 mm long, usually split into 2 parts, 2-keeled, many-nerved; upper bracts 3 or rarely 4, 2–2.3 mm long, 1.2–1.6 mm wide, herbaceous, ovate, acute, 9–11-nerved, acute, each subtending an axillary spikelet and surrounding a central, terminal female spikelet; axillary spikelets sterile or female, 2–3.2 mm long including the pedicel, when sterile composed of a 2-keeled prophyll and 1–3 bracts, when fertile, bearing 3 bracts above the prophyll, each bract subtending a solitary, axillary spikelet, and surrounding a central, terminal female spikelet; female spikelet a solitary female flower; achenes 1–1.2 mm long, 0.8–1 mm wide, lenticular; utricle with the base elliptic in outline, slightly thickened and forming a low, trilobed collar around the achene, the upper part a hyaline, pale brown, puberulent sac closely appressed to the smooth stramineous achene; beak 0.1 mm long; stigmas 2.

Calyptracarya delascioi is known only from the type collection. It grew in shallow water of a small stream in the shade of a low gallery forest through the *Trachypogon* savanna that covers most of the mesa top. At the time of the collection, the leaves and culms were mostly floating on the surface of the water.

This species is named for Mr. Francisco Delascio Chitty, a co-collector of the type collection.

Calyptracarya delascioi differs from all other species in the genus in the development of long, slender rhizomes; all other species are cespitose. In *C. irwiniana* Koyama, however, lateral culms are produced that eventually arch and bend toward the ground. Spikelets often become proliferated and produce new shoots that take root (Koyama,

1969b). This species is thus functionally stoloniferous. The central culms of *C. glomerulata* (Brongn.) Urban also occasionally reproduce plantlets in the inflorescence through proliferation of spikelets.

Calyptracarya delascioi may be most closely related to *C. montesii*. See the discussion of that species for a comparison.

INFLORESCENCE MORPHOLOGY

The inflorescence morphology of *Calyptracarya* has been consistently misinterpreted in recent years (Eiten, 1976; Koyama, 1967, 1969a, b, 1971). For example, Koyama (1967) described the spikelets as “compound, sessile or short-peduncled; glumes 6 (including a prophyll); prophyll and the lower 2 empty; the upper 3 bearing an axillary staminate floret; fructification solitary, terminal.” A similar interpretation was accepted by Eiten (1976).

The typical compound spikelet, such as in *Calyptracarya glomerulata*, that is borne toward the tip of a globose head and that matures an achene bears, in fact, 5 bracts (Fig. 4). The lowest bract subtends a reduced axillary branch system that bears a 2-keeled prophyll as its first foliar bract. Both the lowest bract and prophyll do not subtend flowers. Three multinerved bracts are borne successively above the prophyll, each subtending an axillary sterile spikelet. Koyama (1967) considered these axillary spikelets to be staminate spikelets but, after examining spikelets of all species except *C. irwiniana*, of which we have not seen authentic material, we have never observed any stamens or even the remains of filaments in these spikelets. Even *C. irwiniana*, judging from the published illustration (Koyama, 1969b), appears to conform to the general pattern in the other species. The sterile axillary spikelets consist of a pedicel bearing a basal two-keeled prophyll, usually followed by two or three bracts. These two or three bracts are clearly separate in some species (e.g., some specimens of *C. poeppigiana* Kunth, *C. delascioi*, and *C. bicolor* (Pfeiffer) Koyama, and many specimens of *C. luzuliformis* and *C. monocephala*); however, in certain species (e.g., *C. montesii*, *C. glomerulata*) and some specimens of most other species, the upper two bracts appear to have their margins

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FIGURE 2. *Calyptracarya delascioi* Davidse & Kral (from holotype).—a. Habit sketch.—b. Leaf tip.—c. Lower side of mid blade of leaf.—d. Node from mid culm with attached leaf sheath, adaxial view.—e. Inflorescence head composed of globose clusters of compound spikelets.

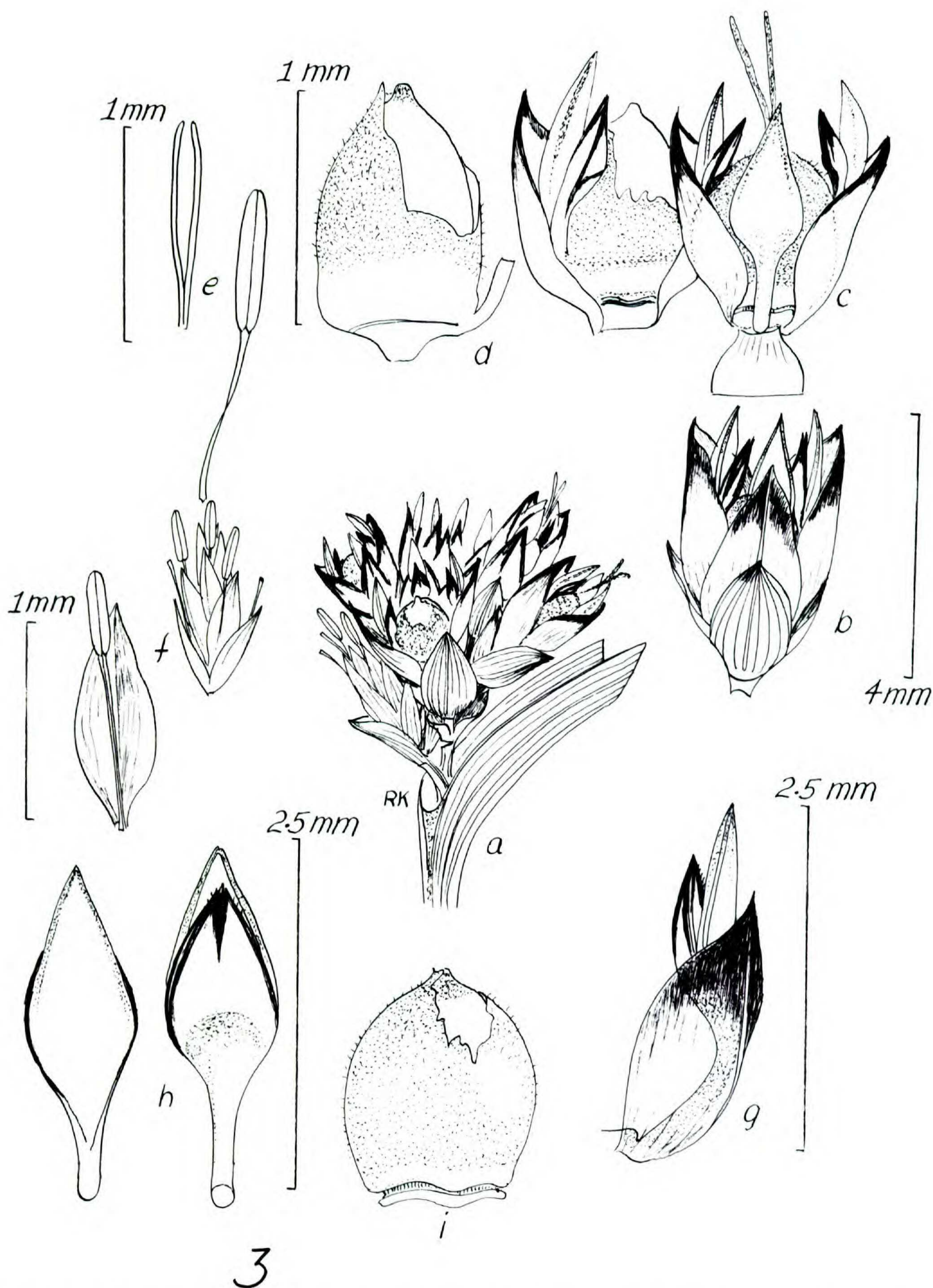


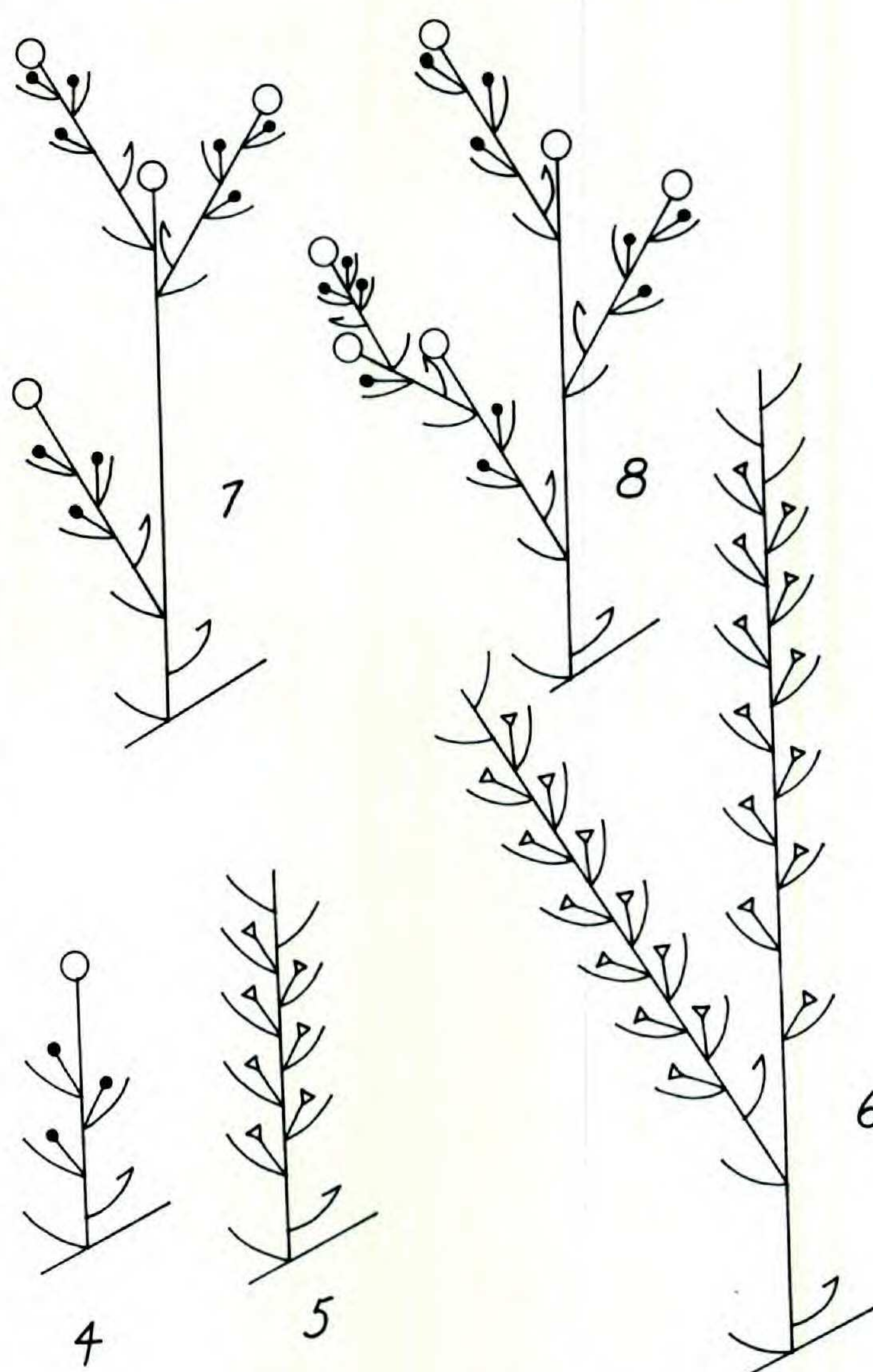
FIGURE 3. *Calyptrocarya delascioi* Davidse & Kral (from holotype).—a. Inflorescence head with male branch at lower left.—b. Female compound spikelet.—c. Female compound spikelet: left, showing upper pseudowhorl of bracts, sterile spikelet whorl, fruit; right, figure with base of one upper bract pulled downward to show the abaxial side of the sterile spikelet which it subtends.—d. Utricle and enclosed achene.—e. Stigma apparatus, left; stamen, right.—f. Staminate bract and its stamens, left; reduced male compound spikelet, right.—g. Side-oblique view of an inner pistillate bract and a sterile spikelet.—h. Abaxial view of sterile spikelet (from g), left; adaxial view of sterile spikelet, right.—i. Mature fruit.

fused, thus appearing to be a single two-keeled structure. In any case, the compound spikelets near the tip of the globose heads are functionally female with never any evidence of stamens.

The functionally male compound spikelets are borne separately at the base of each inflorescence head and often also near the tip of each head, depending on the species. The number of parts is much more variable in the male compound spikelets than in their female counterparts. As in the female compound spikelets, the typical male compound spikelet is borne in the axil of a bract and the first bract on the axis is a two-keeled prophyll. The axis beyond the prophyll may be branched or not. When it is unbranched (Fig. 5), the bracts are spirally arranged, and each subtends a solitary stamen which represents the male flower. Typically, the uppermost one to six bracts in a male compound spikelet are reduced or rudimentary. There is no morphological evidence of a pistil in any of the male compound spikelets that we have observed.

In branched male compound spikelets (Fig. 6), the branch within the spikelet is borne in the axil of a bract, and the first bract on the branch is a two-keeled prophyll. All subsequent bracts except the uppermost subtend solitary stamens. In some male spikelets of *C. poeppigiana* that are branched once again, the distinction between the lowest basal bract and prophyll from the bracts subtending stamens is difficult to observe, because the bracts become smaller and narrower towards the tip of each compound spikelet. An additional difficulty is that either the lowest basal bract or prophyll may sometimes be absent.

It is unlikely, as maintained by Eiten (1976) and Koyama (1967, 1969a, b, 1971), that the axillary spikelets borne below the terminal pistil in the female compound spikelet of *Calyptracarya* (Fig. 4) are staminate or rudimentary staminate spikelets. Rather, it seems certain that these sterile axillary spikelets represent rudimentary female spikelets of a branched female compound spikelet. This interpretation is based on three observations: (1) We have not been able to confirm the presence of stamens in such spikelets, contrary to the assertions of Koyama (1967, 1969a, b, 1971) and Eiten (1976). (2) The branched male compound spikelets are morphologically equivalent to the branched female compound spikelets. The main difference is that almost all female compound spikelets uniformly contain three branches, whereas the male compound spikelets are commonly two-branched, less uncommonly unbranched, and least commonly more than two-branched. (3) Compar-



FIGURES 4-8. Schematic diagrams of compound spikelets of *Calyptracarya* species.—4. Simple female compound spikelet of *C. glomerulata*.—5. Simple male compound spikelet of *C. montesii*.—6. Branched male compound spikelet of *C. monocephala*.—7, 8. Branched female compound spikelets of *C. luzuliformis*. Symbols: large open circles = fertile female flowers; small closed circles = sterile female spikelets; open triangles = fertile male flowers; curved lines = bracts; hooked curved lines = prophylls.

ison of a gradation series of female compound spikelets in different *Calyptracarya* species shows that the axillary spikelets represent female spikelets. That the relatively simple structure of the female compound spikelet in *C. glomerulata* (Fig. 4) and *C. montesii* (Fig. 1g) represents a reduction may be seen by comparing them with the female compound spikelets of *C. bicolor*, *C. delascioi*, *C. monocephala*, and *C. luzuliformis*. In *C. bicolor* and *C. delascioi*, the axillary spikelets commonly bear larger and additional bracts compared with those of *C. glomerulata*. Such axillary spikelets in *C. bicolor* are still nonfunctional and usually do not bear a pistil. In *C. delascioi*, *C. luzuliformis*, and *C. monocephala*, on the other hand, the ax-

illary spikelets that surround the solitary terminal pistil are frequently fully developed, each in turn bearing a fully developed functional terminal pistil surrounded by three lateral bracts, and each of these bearing a solitary axillary sterile spikelet (Fig. 7). Instances in which these third-order axillary spikelets are functional may also be observed in *C. luzuliformis* (Fig. 8). However, in such cases of third-order branching, the number of branches is often less than three, as in Figure 8 where there are two third-order branches with one of them fertile.

From these three lines of evidence, but especially the last where we have demonstrated intergrading series of axillary spikelets in female compound spikelets from rudimentary to fully developed, the conclusion is inescapable that the axillary spikelets borne below the terminal pistil always represent female spikelets. This means that the female and male compound spikelets of *Calyptracarya* are always borne on completely separate units of the inflorescence, exactly as in many species of *Scleria* Bergius, a closely related genus in the tribe Sclerieae.

The major feature of this interpretation, namely, that the male and female spikelets of *Calyptracarya* are borne on separate inflorescence units, is not new, since Nees (1842) had already correctly described and illustrated the genus as having separate male and female partial inflorescences. His

characterization seems to have been misinterpreted by many subsequent students of the genus, probably through false analogy with other scleroid and mapanioid genera.

Eiten's diagnosis of *Calyptracarya* was slightly different from Koyama's interpretation in that she noted and, in fact, illustrated (Eiten, 1976, fig. 14) axillary spikelets lacking male flowers. However, she also indicated that these axillary spikelets usually bear male flowers composed of one stamen.

At anthesis, prophylls in male and female spikelets are often torn and sometimes appear to be two distinct structures. However, this seems to result from the expansion and growth of spikelets at anthesis, and in the female spikelets especially from expansion of the achene. This commonly torn prophyll seems to be responsible for the assertion by Nees (1842), Koyama (1967, 1969a, 1971), and Eiten (1976) that the ultimate unit of the *Calyptracarya* inflorescence is composed of six bracts. In fact, the intact prophyll can be observed readily in very young spikelets of all species and is even easily visible intact in the narrow, postanthesis male compound spikelets of *C. luzuliformis* and *C. monocephala*. It is true, as in an unusual spikelet of *C. delascioi* that we observed, that four rather than three bracts may rarely subtend the central, terminal pistil. But such cases are clearly anomalous and do not affect our interpretation of the structure of the prophyll.

KEY TO THE SPECIES OF *CALYPTROCARYA*

- 1a. Inflorescence composed of headlike, sessile, or nearly sessile clusters of spikelets.
 - 2a. Heads solitary per culm *C. monocephala*
 - 2b. Heads several per culm.
 - 3a. Stigmas 3; plants cespitose; involucre bracts conspicuous, longer than the head; heads usually 2 per culm *C. montesii*
 - 3b. Stigmas 2; plants rhizomatous with elongated rhizomes; involucre bracts inconspicuous, shorter than the head; heads 3–8 per culm *C. delascioi*
- 1b. Inflorescence composed of some peduncled globose clusters of spikelets arranged in a cymose panicle.
 - 4a. Stigmas 3; leaf blades less than 5 mm wide; utricle pubescent *C. luzuliformis*
 - 4b. Stigmas 2; leaf blades sometimes wider than 5 mm; utricle puberulent.
 - 5a. Culms lateral *C. irwiniana*
 - 5b. Culms central.
 - 6a. Achenes 1.2–1.5 mm wide, 1–1.5 mm long *C. glomerulata*
 - 6b. Achenes 1.6–2.2 mm wide, 1.7–2.2 mm long.
 - 7a. Upper basal leaves 5–9(–12) mm wide, attenuate at the apex, mostly longer than 25 cm *C. poeppigiana*
 - 7b. Upper basal leaves (8–)10–28 mm wide, abruptly acute at the apex, mostly shorter than 25 cm *C. bicolor*

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